Assessment of flocculation, settling and consolidation of cohesive sediments using the zeta potential

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The aim of this paper is to link the flocculation, settling and consolidation of cohesive sediments through the colloidal properties of clays. Flocs are formed by the aggregation of clays and polymers depending on the presence of ions (Mietta *et al.,* 2009). Due to electrostatic interactions (Coulomb, van der Waals, …) bridging between polymer and particles occurs. Cationic, anionic and uncharged polymers will be used in this study, to demonstrate the role of surface charge in the binding to the clay.

The bridging of polymers to clay particles is evaluated through the study of the interfacial properties of the clay-polymer system by electrophoretic mobility measurements. From these measurements, an estimation for the surface charge of the clay is obtained in terms of the zeta potential.

The zeta potential has proven to be a good indicator for predicting the changes (changes in particle size, density and floc strength) of clayey materials as a function of the fluid properties (changes in salinity, pH, shear stresses) (Chassagne *et al*., 2009; Mietta *et al*., 2009; Ibanez *et al*., 2014).

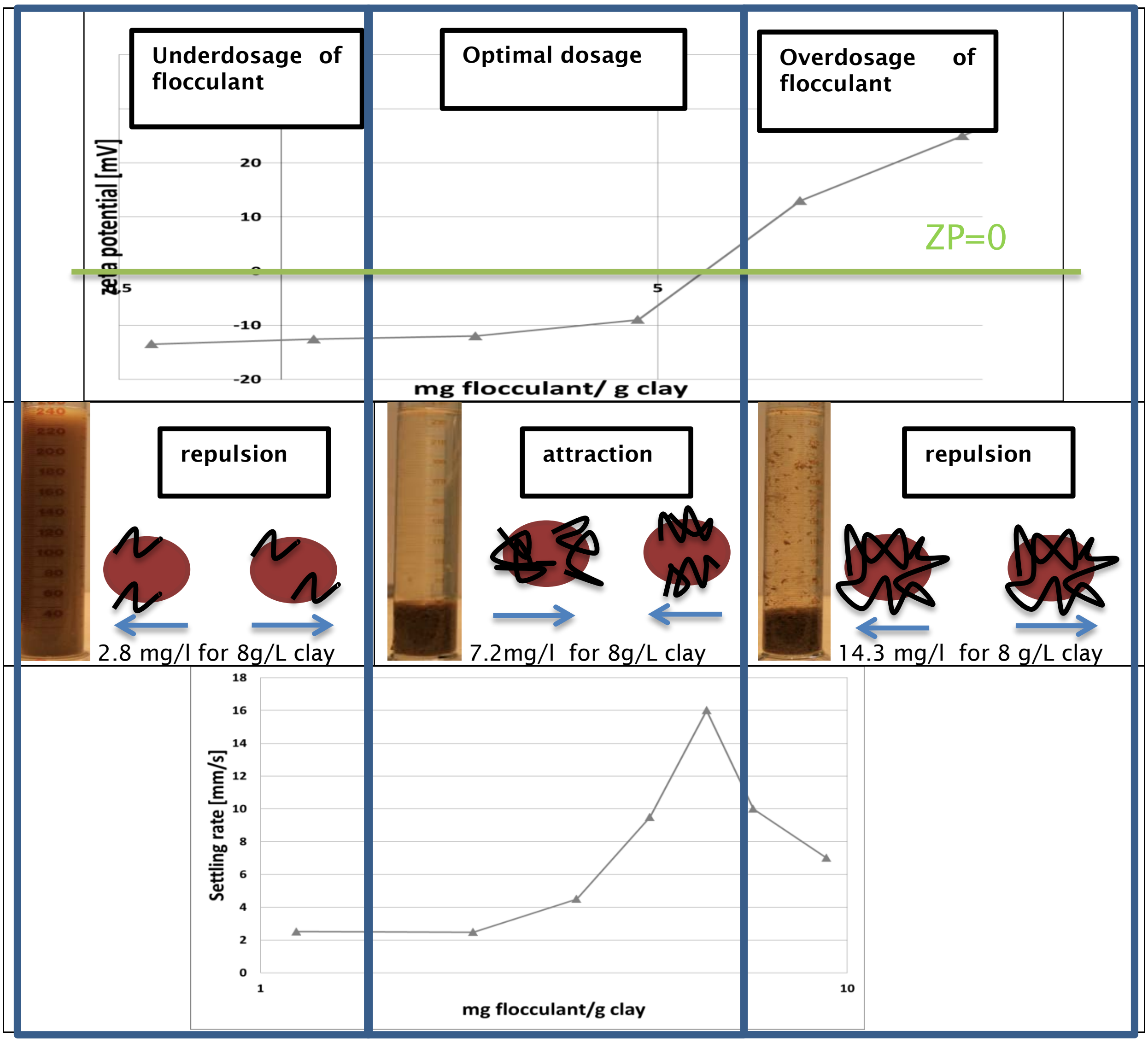
These changes can in turn be related to changes in settling and consolidation behaviour (Merckelbach *et al*., 2002; Winterwerp, 2002; Merckelbach and Kranenburg, 2004).

The figure below illustrates the results obtained when studying settling velocity and flocculation as function of the amount of added cationic polymer. Three regions can be defined:

1. Underdosage of flocculant: for lower dose, the repulsive forces between particles (negatively charged in the absence or low amount of cationic polymers) do not allow flocculation, and hence settling does not occur.

2. Optimal dosage: cationic polymers attach to the negatively charged particles, neutralizing their electrokinetic charge and making aggregation possible. At neutral zeta potential, flocculation is optimal and the supernatant is clear, indicating that we have reached the optimal polymer coverage and the settling velocity is the highest in this moment.

3. Overdosage of flocculant: when the optimum dose is exceeded, flocculation still occurs, but at a lower rate. This is caused by the “excess” of positive charges at the clay surface, which increase the time for positive particles to encounter a negatively charged zone. The resulting flocs are large because of their high polymers content (particles bind not with each other, but with many polymers in between). When the flocculant dose is further increased, all particles become too positively charged, resulting in mutual steric repulsion, and a decrease in the settling velocity.



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